Center for Computational Seismology (CCS)

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RESEARCH OBJECTIVES

The Center for Computational Seismology (CCS) serves as the core data processing, computation and visualization facility for seismology-related research at LBNL. As such, it will be integral to our critical efforts in mapping the distribution and migration of fluids in the subsurface, a problem requiring new approaches in seismic waveform inversion techniques that can take into account the presence and effects of diffracted waves. A wide range of research projects relies upon CCS resources for development and application of methods for characterization, process definition and process monitoring in the rock-fluid-thermochemical subsurface environment. Pursuing an objective of providing modern tools for seismological research, the Center is designed and operated to provide a focused environment for research in modern computational seismology by scientists whose efforts at any time may be distributed among diverse research projects. A large number of varied, separately funded research projects, from many different sponsors, rely upon this resource for intellectual exchange as well as computational needs. Ph.D. theses and journal publications reveal a spectrum of effort from the most fundamental theoretical studies to field applications at all scales.

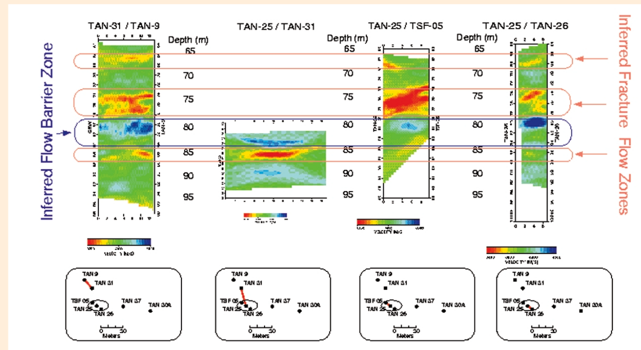

Figure 1. Seismic velocity tomograms (top) from the INEEL TAN site with location map (bottom) showing well pair. Zones of low velocity (yellow-red) are interpreted as fractured basalt (possibly rubblized contacts between basalt flows), which allows high flow within the aquifer. High-velocity zones (blue) are reinterpreted as dense, unfractured basalt that acts as a barrier to contaminant flow within the aquifer. The upper two inferred flow zones have been confirmed as contaminant transport zones by well logs.

APPROACH

CCS provides a specially equipped and staffed computational facility to support and advance a wide-ranging program of seismological research. Beyond computers, workstations, seismic processing packages and visualization capabilities, it is a physical facility in which scientists pursuing individual research interact with other scientists and technical support staff in a multidisciplinary intellectual environment. CCS supports research in the general areas of wave propagation, geophysical inverse methods, earthquake and explosion source theory, seismic imaging, borehole geophysics, four-dimensional process monitoring and visualization technology.

ACCOMPLISHMENTS

Results from the diverse seismological program at CCS are best demonstrated in the CCS research output. Major accomplishments flow largely from the breadth of research support provided by CCS, and the cross-fertilization between applications and fundamental studies. Significant recent results involve successful imaging of contaminant flow zones in fractured basalt, development of borehole orbital vibrator technology and promising results in CO_2-monitoring with borehole imaging methodology.

SIGNIFICANCE OF FINDINGS

Findings for a facility and scientific environment such as that provided by CCS must be defined in the context of the multidisciplined research base that is supported there, rather than project-specific accomplishments (those appear in other sections of this report). It is fair to attribute a large part of the scientific reputation in seismology at LBNL to the CCS environment.

RELATED PUBLICATIONS

Byun, J., and J.W. Rector, Wide angle effects in cross-well reflection imaging, J. Seismic Explor., in press.

Gritto, R., V.A. Korneev and L.R. Johnson, Nonlinear 3-dimensional inversion of low frequency scattered elastic waves, Pure & Appl. Geoph., in press.

Hubbard, S.S., Y. Rubin and E. Majer, Spatial correlation structure estimation using geophysical and hydrogeological data, Water Resources Research, vol. 35, no. 6, 1809-1825, 1999.

Keers, H., L. Johnson and D. Vasco, Crosswell imaging using asymptotic waveforms, Geophysics, submitted.

Nadeau, R.M., and T.V. McEvilly, Fault slip rates at depth from recurrence intervals of repeating microearthquakes, Science 285, 516-519, 1999.

Parker, P., Genetic algorithms and their use in geophysical problems, 1999.

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